# STUDY GUIDE

## GENERAL WASTEWATER

## INTRODUCTION
## AND
## ADVANCED

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## PREFACE

This operator's study guide represents the results of an ambitious program. Operators of wastewater facilities, regulators, educators and local officials, jointly prepared the objectives and questions for the General Wastewater Introduction and Advanced exams.

The objectives in this study guide have been organized into six modules:

(A) History, and Water Pollution; (B) Characteristics of Wastewater, and Collection; (C) Lift Stations, and Processes; (D) Equipment, Operation, and Maintenance; (E) Flow Monitoring and Sampling; and, (F) Safety, Calculation, and Regulation. The objectives are organized to correspond to the major concepts in each module.

New exam questions have been written to correspond to the concepts included in this study guide.

## HOW TO USE THESE OBJECTIVES WITH REFERENCES

In preparation for the General Wastewater Exams, you should:

1. Read all the objectives and write down the answers to the objectives that readily come to mind.

2. Use the resources at the end of the objectives to look up those answers you are not sure of.

3. Write down the answers found in the resources to those objectives you could not answer from memory.

4. Review all answered objectives until you can answer each from memory.

**IT IS ADVISABLE THAT THE OPERATOR ATTEND SOME FORM OF FORMAL TRAINING IN THIS PROCESS BEFORE ATTEMPTING THE CERTIFICATION EXAM.**

### Choosing A Test Date

Before you choose a test date, consider the training opportunities available in your area. A listing of training opportunities and exam dates can be found in the annual DNR "Certified Operator", or by contacting DNR District operator certification coordinator.

# INTRODUCTION

## INTRODUCTION TO GENERAL WASTEWATER

## MODULE A: SOURCES AND CHARACTERISTIC OF WASTEWATER

### CONCEPT: SOURCES OF WASTEWATER

**1.** Discuss the early historical methods of dealing with wastewater.

**2.** Describe the sources of wastewater in a community.

**3.** List and define the common sources of infiltration.

**4.** List and define the common sources of inflow.

### CONCEPT: CHARACTERISTICS OF WASTEWATER

**5.** Define the terms Aerobic and Anaerobic conditions, and the importance in wastewater treatment.

**6.** Describe the physical characteristics of raw wastewater in terms of color, odor, and temperature.

**7.** Define the following:

A. pH.
B. BOD
C. Suspended Solids.
D. Dissolved Solids.
E. Total Solids.

**8.** Describe the general chemical characteristics of raw wastewater in terms of pH, BOD, and Suspended Solids.

**9.** Explain the effect on plant operations of the following problems associated with raw wastewater:

A. Septic Conditions.
B. Oil and Grease.
C. Solvents.
D. Gasoline.
E. Toxics.

## MODULE B: COLLECTION AND FLOW MONITORING

### CONCEPT: COLLECTION OF WASTEWATER

**10.** Trace the sequence of events from the time one flushes a toilet until treated wastewater reaches a receiving stream.

**11.** Explain the collection system and the function of the following:

A. Combined Sewers.
B. Separate Sanitary Sewers.
C. Storm Sewers.

**12.** Describe the purpose of a lift station.

### CONCEPT: FLOW MONITORING

**13.** Explain the importance of wastewater flow measurement.

**14.** List the common types of flow measuring and water level measurement devices.

**15.** Describe where flow meters should be located to accurately measure influent flows.

**16.** Explain effluent flow measurement.

## MODULE C: TREATMENT AND EQUIPMENT

### CONCEPT: TREATMENT OF WASTEWATER

**17.** Develop an operators daily checklist for routine activities at a wastewater treatment plant.

**18.** Describe and explain the function of common Preliminary wastewater treatment processes.

**19.** Explain the Primary wastewater treatment process.

**20.** Discuss how detention time affects the results of Primary clarification.

**21.** Describe the function of a Stabilization Pond system.

**22.** Describe the following types of secondary biological wastewater treatment units:

A. Attached Growth (RBC/Trickling Filter).
B. Suspended Growth (Activated Sludge).

**23.** Describe the following types of Tertiary wastewater treatment systems:

A. Physical Pollutant Removal.
B. Chemical Pollutant Removal.

**24.** Explain the types and purposes of systems used for effluent Disinfection of wastewater.

**25.** Discuss the Anaerobic Digestion unit process.

### CONCEPT: EQUIPMENT

**26.** Describe the following valves used in a wastewater treatment plant:

A. Gate Valve.
B. Check Valve.
C. Plug Valve.
D. Pressure Relief Valve.
E. Butterfly Valve.
F. Telescopic Valve.

**27.** Discuss where electric, diesel, and gasoline motors would typically be found at a wastewater treatment plant.

**28.** Describe the following pumps and their use in wastewater treatment:

A. Centrifugal.
B. Submersible.
C. Nonclogging.
D. Airlift.
E. Trash.
F. Positive Displacement Piston.
G. Positive Displacement Metering.
H. Diaphragm.
I. Progressive Cavity.

**29.** Identify the basic parts of a centrifugal pump.

**30.** State how often a flow meter must be calibrated.

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## MODULE D: MAINTENANCE AND SAMPLING

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### CONCEPT: MAINTENANCE

**31.** List the steps necessary in setting-up a preventive maintenance system for equipment and facilities at a wastewater treatment plant.

**32.** Explain how to prevent grease and grit build-up in lift station wetwells.

**33.** Describe various grease and grit clean-up procedures used in lift station wetwell maintenance.

**34.** Develop a routine lubrication maintenance schedule for all wastewater treatment plant equipment.

**35.** Develop a planned maintenance list for each of the following:

A. Centrifugal Pumps (with packing or mechanical seals).
B. Submersible Pumps.
C. Motors.
D. Valves.

**CONCEPT: SAMPLING**

**36.** Give examples of good sampling point locations when collecting representative raw wastewater samples.

**37.** Explain the items to consider in collecting a representative sample.

**38.** Define grab and composite samples.

**39.** Describe flow proportional sampling.

**40.** Describe the temperature requirements for sample preservation.

**41.** List the information which must be recorded for every sample.

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## MODULE E: SAFETY AND CALCULATIONS

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**CONCEPT: SAFETY**

**42.** Identify the most toxic gas found at a wastewater treatment plant.

**43.** List the safety precautions necessary to ensure that the air in a manhole or lift station is safe.

**44.** List the proper actions to take in case of a confined space accident.

**45.** List some common electrical safety precautions for operators at wastewater treatment plants.

**46.** Describe the main safety hazard with Anaerobic Digesters.

**CONCEPT: CALCULATIONS**

**47.** Convert the following:

A. Gallons Per Day (GPD) to Million Gallons Per Day (MGD).
B. Gallons Per Minute (GPM) to Million Gallons Per Day (MGD).

**48.** Given data, convert influent concentration and flow to pounds per day.

**49.** Given data, calculate the volume in gallons of both rectangular and round clarifiers.

**50.** Given data, calculate pump capacity in gallons per minute for the following situations:

A. With the Influent Flow Shut-off (Not Always Possible).
B. With the Influent Flow Continuous During Test.

**51.** Given data, compute the plant or unit process percent BOD efficiencies.

**52.** Given data, calculate the detention time (in hours) for a clarifier.

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## MODULE F: EFFLUENT DISCHARGE, SLUDGE TREATMENT AND SLUDGE DISPOSAL

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**CONCEPT: EFFLUENT DISCHARGE**

**53.** Discuss the health concerns related to the discharge of treated wastewater.

**54.** Discuss the water pollution concerns related to the discharge oftreated wastewater.

**CONCEPT: SLUDGE HANDLING/TREATMENT**

**55.** List some typical sludge handling/treatment processes found at wastewater treatment plants.

**CONCEPT: SLUDGE DISPOSAL**

**56.** List the common methods of sludge disposal.

# ADVANCED

## ADVANCED GENERAL WASTEWATER

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## MODULE A: SOURCES AND CHARACTERISTICS OF WASTEWATER

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### CONCEPT: SOURCES OF WASTEWATER

**1.** Explain the effect of excessive infiltration or inflow on a wastewater treatment plant.

**2.** Describe the types of materials prohibited from discharge into sewer systems, and the reasons they should not be discharged.

### CONCEPT: CHARACTERISTICS OF WASTEWATER

**3.** Explain when petroleum contaminated groundwater can be accepted at a treatment plant.

**4.** Discuss the wastewater characteristics and problems with the following Industrial processes:

A. Dairy Operations.
B. Fruit and Vegetable Processing.
C. Metal Finishing.

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## MODULE B: COLLECTION AND FLOW MONITORING OF WASTEWATER

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### CONCEPT: COLLECTION OF WASTEWATER

**5.** Discuss how submersible pumps are used in lift stations.

**6.** Explain how a wetwell/drywell pumping station works.

**7.** Define cross connection and the importance of cross connection control devices.

**8.** Discuss the devices (Backflow Preventers) used in cross connection control in wastewater treatment, and their required inspection and certification interval.

**CONCEPT: FLOW MONITORING OF WASTEWATER**

**9.** Identify where the following flow measuring devices should be located in a wastewater treatment plant.

A. V-Notch Weir.
B. Parshall Flume.
C. Palmer-Bowlus Flume.
D. Magnetic Flow Meter.
E. Ultrasonic.

**10.** Explain how the following water level measurement devices are used.

A. Floats.
B. Ultrasonic Devices.
C. Bubbler Tube Systems.
D. Diaphragm Bulb Systems.

**11.** List the conditions to consider in the placement of open channel flow meters.

**12.** Explain the possible causes for operational problems with open channel flow meters.

**13.** Describe how a magnetic flow meter works and is installed.

## MODULE C: TREATMENT AND EQUIPMENT OF WASTEWATER

**CONCEPT: TREATMENT OF WASTEWATER**

**14.** Describe the following Preliminary treatment processes.

A. Bar Screen.
B. Grit Removal.
C. Comminution/Barminutor.

**15.** Explain how to clean bar screens and dispose of the debris.

**16.** Describe the following ways wastewater treatment plants use to control odors:

A. Aeration.
B. Chlorination.
C. Other Chemicals.
D. Odor Management.

**17.** State the overall BOD and Suspended Solids removal efficiencies expected from the Primary treatment process.

**18.** Discuss what photosynthesis is and how it aids the biological treatment of wastewater in Stabilization Ponds.

**19.** State the overall BOD and Suspended Solids removal efficiencies expected from a Biological secondary treatment system.

**20.** Explain the function of a Secondary Clarifier.

**21.** State the overall BOD and Suspended Solids removal efficiencies expected from the Tertiary treatment process.

**22.** List waterborne diseases that can be expected in wastewater flows caused by bacteria, viruses or parasites, and describe their importance to public health.

**CONCEPT: EQUIPMENT IN WASTEWATER**

**23.** Explain what pump "cavitation" is, what it sounds like, and it's possible causes and corrective actions.

**24**. Discuss the purposes and methods of priming a centrifugal pump.

**25.** Describe why a centrifugal pump might lose prime.

**26.** Describe the common electrical, mechanical, and physical, operational problems with lift stations, and suggest corrective actions.

**27.** Describe the use of an amp-probe to troubleshoot possible pump problems.

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## MODULE D: MAINTENANCE AND SAMPLING

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**CONCEPT: MAINTENANCE**

**28.** Develop a planned (preventive) maintenance outline for a standard wetwell/drywell lift station with an emergency generator.

**CONCEPT: SAMPLING**

**29.** Describe the common causes of the following sampling errors, and explain how they might alter laboratory results:

A. Poor Sampling Location.
B. Improper Use of Grab or Composite Sampling.
C. Sampling Equipment not Properly Cleaned.
D. Composite Sampler not Cold Enough for Storage.
E. Improper Chemical Preservation.
F. Selective Sampling.
G. Feed Line Problems.

**30.** Explain the relationship between a flow meter totalizer reading and sample collection. Be able to identify what day each represents.

**31.** Explain what to do with laboratory analysis if:

A. There are Problems with the Sampler.
B. A Sample is Lost.
C. An Emergency Exists at the Plant.
D. Poor Quality Effluent is Sampled.

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## MODULE E: MANAGEMENT AND CALCULATION

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### CONCEPT: MANAGEMENT OF WASTEWATER TREATMENT PLANTS

**32.** Define the following common types of plans used in the management of a wastewater treatment plant:

A. A Strategic Plan.
B. A Contingency Plan.
C. A Program Plan.
D. A Capital Facility Plan.
E. A Financial Plan.

**33.** Create a list of steps an efficient wastewater treatment plant manager uses to develop sound problem solving and decision making solutions.

**34.** Develop a list of obstacles to good in-plant communications a plant manager must be aware of.

**35.** Explain the importance of budgets, and distinguish between the following types of budgets:

A. Operations and Maintenance Budget.
B. Capital Improvements Budget.

**36.** Discuss the importance of each of the following key managerial plans or systems:

A. Safety and Health Plan.
B. Emergency Operating Plan.
C. Financial Management Plan.
D. Process Control Plan.
E. Energy Conservation Plan.
F. Maintenance Management Plan.
G. Laboratory Management Plan.

**CONCEPT CALCULATION**

**37.** Given data, calculate the best setting for the "flow pulse" interval on an automatic sampler.

**38.** Given data, calculate plant loadings from plant influent and plant sidestreams.

**39.** Given data, calculate detention time for multiple clarifiers operating in parallel.

**40.** Given data, calculate pump capacity in gallons per minute using the time-volume method.

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## MODULE F: SLUDGE TREATMENT AND DISPOSAL

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**CONCEPT: SLUDGE TREATMENT**

**41.** Compare the sources and characteristics of primary and secondary sludges.

**42.** Explain the reasons for sludge treatment.

**43.** Compare Anaerobic and Aerobic Sludge Digestion.

**CONCEPT: SLUDGE DISPOSAL**

**44.** Describe the requirements for land application of sludge.

## RESOURCES

1. **ADVANCED WASTE TREATMENT**. 1st Edition (1987), Kenneth D. Kerri.California State University, 6000 J Street, Sacramento, CA 95819-6025. Phone (916) 278-6142.

2. **CROSS-CONNECTION CONTROL MANUAL**. (1990). Wisconsin Department of Industry, Labor and Human Relations, 201 East Washington Ave., Room 141, P.O. Box 7969, Madison, WI 53707. Phone: Delores Wylesky, (608) 266-0521.

3. **FIELD MANUAL FOR PERFORMANCE EVALUATION AND TROUBLESHOOTING AT MUNICIPAL WASTEWATER TREATMENT FACILITIES**. EPA - 430/9-78-001 (1978). U.S. Environmental Protection Agency, Municipal Operations Branch, Office of Water Program Operation, Washington, DC 20090. (Can also be purchased through National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161).

4. **ISCO OPEN CHANNEL FLOW MEASUREMENT HANDBOOK**. 2nd Edition (1985). ISCO, Inc., P.O. Box 82531, Lincoln, NE 68501.

5. Kulin, Gershon. **RECOMMENDED PRACTICE FOR THE USE OF ELECTRO-MAGNETIC FLOWMETERS IN WASTEWATER TREATMENT PLANTS**. Publication 85-122-737 (1984). **RECOMMENDED PRACTICE FOR FLOW MEASUREMENT IN WASTEWATER TREATMENT PLANTS WITH VENTURI TUBES AND VENTURI NOZZLES**. Publication 85-121-663 (1984). **RECOMMENDED PRACTICE FOR THE USE OF PARSHALL FLUMES AND PALMER-BOWLUS FLUMES IN WASTEWATER TREATMENT PLANTS**. Publication 85-122-745 (1984). U.S. Environmental Protection Agency, National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

6. **OPERATION OF MUNICIPAL WASTEWATER TREATMENT PLANTS**. Manual of Practice No.11 (MOP 11), 2nd Addition (1990), Volumes I,II,andIII. Water Environment Federation (Old WPCF), 601 Wythe Street, Alexandria, VA 22314-1994. Phone (800) 666-0206.

7. **OPERATION OF WASTEWATER TREATMENT PLANTS**. 3rd Edition (1990), Volumes 1 and 2, Kenneth D. Kerri, California State University, 6000 J Street, Sacramento, CA 95819-6025. Phone (916) 278-6142.

8. **OPERATION OF WASTEWATER TREATMENT PLANTS**. Manual of Practice No.11 (MOP 11)(1976). Water Pollution Control Federation, 601 Wythe Street, Alexandria, VA 22314-1994. Phone (800) 666-0206. (Probably Out-Of-Print, See Reference Number 6).

9. **PRIME MOVERS: ENGINES,MOTORS,TURBINES,PUMPS,BLOWERS AND GENERATORS**. Manual of Practice OM-5 (MOP OM-5) (1984). Water Environment Federation (Old WPCF), 601 Wythe Street, Alexandria, VA 22314-1994. Phone (800) 666-0206.

10. **STABILIZATION POND OPERATION AND MAINTENANCE MANUAL**. Sexauer, Willard and Karn, Roger (1979). Operator Training Unit, Minnesota Pollution Control Agency, 1935 West County Road B-2, Roseville, MN 55113. Phone (612) 296-7373.